THE TELEGRAPHIC JOURNAL.

VOL. III.—No. 60.

FRANK IVES SCUDAMORE, C.B.

ALL telegraphists in England will learn with great regret that they are about to lose the able chieftainship of Mr. Scudamore. He has accepted an appointment in Turkey, to organise the International postal system of that country—a task for which he is pre-eminently qualified. His thirty-five years' invaluable, active, and zealous services in the Post-office have secured him a richly-deserved pension. He proceeds to Stamboul in a very short time.

Although Mr. Scudamore has been the organiser of several reforms in the Post-office, and has introduced savings bank and insurance business into the commercial *rôle* of "a nation working for itself," it will be his telegraphic enterprise which will chiefly distinguish him. Officers of the old telegraph companies will remember, when early rumours of State purchase were muttered, with what dread the name of Scudamore was received, as some monstrous ogre about to swallow them up; and how this dread was changed into affection and respect, when, on their transference to his control, they experienced his geniality, his power, his ability, and his marvellous knowledge of detail. He never had a more enthusiastic and zealous staff than that transferred to him by the commercial companies, and none will more regret the loss of his leadership than those who composed it.

There are few feats in connection with telegraphy which will be better remembered than his three days' examination in 1868 before the Committee of the House of Commons.

It is marvellous how telegraphy has thrived under his guidance. The number of offices opened to the public has increased from 2,000 to 5,600. The number of messages sent annually has leapt up from six millions to twenty millions. The average charge for inland messages has been reduced from 2s. 2d. to 1s. 2d. The number of words transmitted for the press has increased from about two millions to two hundred and twenty millions. The mileage of wire has enlarged from 49,000 to 108,000. The number of instruments has sprung from 1,900 to 11,600. Automatic and duplex telegraphy have been introduced. The pneumatic tube system has been largely extended.

Although the financial result of all this extension has not yet satisfied the money-grubbing proclivities of a certain section of the community, there can be no doubt that the public at large is highly gratified with the result of the transference of the telegraphs to the State, and if an opportunity be afforded, it will amply express its satisfaction to the author of the change. He will not depart to his new sphere of labour without receiving the warmest testimony of the confidence felt in him by his own staff, and the sincerest wishes for his prosperity, welfare, and success from all who have ever served with or under him.

THE LIFE OF CABLES.

THERE is a very widespread notion that the life of a submarine cable is of very limited duration, and that investment in such property is very speculative and risky. Facts in their mere historical aspect tend fully to confirm these ideas. All the earlier cables that knit our coasts with the Continent, with Ireland, and with the Channel Islands rapidly disappeared. A cable laid in 1852, and one in 1854, between Holyhead, and two in 1852 between Scotland and Ireland, were total failures. Two cables were lost between Sardinia and Africa in 1855. The first cable between Dover and Calais lasted only a day. The Crimean cable lasted but nine months. The first Atlantic cable remained entire but twenty-three days. The Channel Islands Cable of 1858 lasted three years. The Red Sea Cable of 1859 lasted only six months. On the other hand many cables which are now in existence vary from twenty years old to twenty months. The Dover and Calais, laid in 1851, and the Dover and Ostend, laid in 1853, still speak, though perhaps in the former case, little or any of the original cable remains. The England and Holland cable laid in 1858 is as sound as ever, while that laid to Hanover in the same year lasted but four years.

The existence of all these cables has been so fitful that some cause must exist to account for their irregular lives. So many cables have failed, and so many have succeeded, that sufficient facts have, however, been accumulated to justify some generalization on this point. There is no difficulty in learning lessons from the experience of the past. The materials used, the form in which these materials are fashioned into cables, the way in which they are submerged, and the localities on which they lie, have now had sufficient trial to justify some opinion as to the form of the cables of the future.

There is nothing to show that the main materials employed, whether gutta-percha or indiarubber, are destructible. On the contrary, in the case of gutta percha everything points out that it is practically indestructible. Keep it away from oxygen and from the varying conditions of temperature and climate, and it seems as though it will last for ever.

What action electric currents have upon it is not well known, but experience justifies the opinion that this action, whatever it be, is practically innocuous. In fact, gutta percha wire actually improves in insulation in our deep seas. The Suez-Aden section of the Indian cable, which lies in comparatively warm water, has improved in insulation since its submersion no less than 38 per cent., and many other deep sea cables have improved from 45 to 77 per cent. in the same quality. Gutta-percha, taken up after 25 years' submergence in water, is as perfect as when it was first put down.

But the life of a cable does not always depend upon that of its core. It rather depends upon that of its sheathing, and far more upon the bottom on which it is laid. Those cables that have failed have done so because their sheathing was not adapted to their localities. Heavy cables were laid in deep seas, light cables were laid in shallow seas, rough anchorage ground was crossed by mere pack-threads, rugged rocky bottoms and fierce tideways were spanned with slender ropes. The fact that the sheathing and structure of the cable must be adopted to the bed on which it is intended to lie is scarcely yet sufficiently followed. A cable is projected between two fixed points, a cursory examination is made of the depth of the water and of the nature of the bottom. So many miles of shore ends and so many miles of deep sea cable are specified to be used; sometimes intermediate sizes are introduced. But never has yet a cable been properly designed to meet the full requirements of its future bed. Heavy shore ends needlessly and uselessly rest upon safe and soft bottoms, light sea portions cross rocky bottoms with danger and risk. The great lessons taught by experience are these—that cables must be specially designed for the various portions of the seas they are intended to cross, and that more reliance must be placed on the careful surveys and examination of the bottom.

The durability of a cable does not depend upon the durability of its materials, but upon the special adaptability of its built-up parts to meet those great forces of nature which are present in its future home. Anchors, again, may be dropped which, when raised, strain it to its utmost limit. It is not altogether free from the attacks of insects and other assailants. Experience seems to point out fifteen years as about the average life of past cables; but if the lessons of practice have been carefully studied and followed, there is no reason why this period should not be doubled or even trebled in existing cables, and it is possible to construct, lay, and maintain cables so that they shall be practically permanent.

POST OFFICE TELEGRAPHS.

The following Parliamentary Paper has just been issued.

An Account showing the Gross Amount received during the Year ended 31st December 1874, the Amount of Expenses incurred during the year, and the Balance remaining applicable to pay the Annuities or Interest falling due upon the Securities issued under the Authority of the "Telegraph Act, 1869," and as a Sinking Fund for the Redemption of such Securities.—(Pursuant to Act 32 and 33 Vict. c. 73, s. 20.)

	£	s.	d.
Gross Amount received by the Post Office from the 1st January, 1874, to the 31st December, 1874, in respect of Telegraphic Messages, Private Wire Rentals, Special Wires, &c...	1,601,662	17	10
Less—Amount paid to Submarine Telegraph Companies, being Message Receipts collected on their behalf, and amount allowed to Postmasters in respect of sums paid by them for the special delivery of Messages, &c.	441,124	17	9
	£1,160,538	0	1

	£	s.	d.
Amount expended by the Post Office from 1st January, 1874, to 31st December, 1874, in respect of Salaries, Rent, Maintenance of Telegraphs, &c.	1,051,376	12	2½
Balance remaining applicable to pay the Annuities or Interest falling due upon the Securities issued under the authority of the Telegraph Act, 1869, and as a Sinking Fund for the redemption of such Securities, on the 31st December, 1874	109,161	7	10½
	£1,160,538	0	1

Notes.—1. This Account, like the previous Accounts, is based upon the actual receipts and the actual payments of the Post Office, but as Telegraph expenditure by the Office of Works was, from 1st April, 1874, borne by the Vote for that Department, the sum so paid from 1st April to 31st December, 1874, viz., £20,578, is not included in this Account.

2. During the year 1874, a proportion of the cost of providing sites for certain Post Offices was chargeable to the Telegraph Service; but as the precise proportion so chargeable has not yet been ascertained in each case, the amount has not been included in this Account. The amount is estimated at about £10 950. No provision was made in the Telegraph Vote for these charges until after the close of the year 1874.

3. In this Account is included superannuation allowances to non-effective Telegraph officers for one year and three quarters, of which about £17,800 is proper to the previous year.

GEO. RICHARDSON, Principal Book-keeper.
GEO. CHETWYND, Receiver and Accountant General.

General Post Office,
17th June, 1875.

THE VOLTAIC BATTERY.

A Course of Six Lectures,

By Dr. JOHN HALL GLADSTONE, F.R.S.,

Fullerian Professor of Chemistry, Royal Institution.

Delivered at the Royal Institution of Great Britain.—Christmas, 1874-5.

(Continued from page 137.)

Lecture VI.—The Electric Telegraph.

It was in 1820, little more than half a century ago, that Oersted first noticed the action of the voltaic current upon a magnetic needle. I have had occasion to show you this action two or three times already, but I must show it to you again. We will take this needle, pointing at present to the north with a wire passing over it. By just making contact between the wire and a battery, we shall find that the needle will turn round. There you see the needle turning away at right angles. Now, of course, we can make and break as we please, and by sending the current the other way, the needle will turn over to the other side. So we can make it go either to the right or to the left. Now this has led to the invention of what are called galvanometers. This is the simplest form of galvanometer, but if, instead of taking a straight wire we made it coil round many times, and especially if we take what is called an astatic needle, that is, two needles which are fastened together with their poles reversed, so that the north pole of one is over the south of the other with the wire passing between, we should be able to produce movements of the needle by exceedingly feeble currents. You are aware that this has been fully carried out in Thomson's galvanometer which we have here. I explained that to you on a previous occasion, and I showed you then that there was a very small mirror suspended on the needle, and how we were able to throw a light from that moving mirror upon the screen.

See what may be done with an ordinary galvanometer. I can move the needle which way I please, or reverse it as often as I like, by the power that comes from the battery. Now, we can attach meanings to these movements of the needle. We can read one as "A" and another as "B," and so on. We might then carry the instrument to that table. I have only to make the wire longer for that purpose, or I might take the instrument up into the gallery, and do just the same as I have been doing here. But I need not be content with that, for I could take this instrument out into Albemarle-street or Piccadilly; or I might carry it to Brompton or Bayswater, and still, if there was a sufficiently long wire, the voltaic force would flow through and reach the instrument, and our needle would act in response to what took place here. Now, you see by giving certain meanings to these swingings of the needle; we can make communications at a distance to those places I have spoken of, for instance, or to Birmingham or Edinburgh, or anywhere else; and hence, we have the invention of the electric telegraph.

In the same year that Oersted noticed this movement of the needle, another great electrician, Ampére, suggested it as a means of indication at a distance. Communication by means of electricity had been suggested before that, but I believe that there was no actual electric telegraph made and used till Gauss and Weber, who were making certain observations in 1833, carried a wire from their physical cabinet to their observatory and back again—a distance of a mile—and made a needle swing, and were thus able to communicate from one place to the other. There were partially successful attempts by Ritchie and others, I believe, in this building, but we may go on to the year 1837, when Cooke and Wheatstone took out their patent for the electric telegraph, and then commenced the actual use of the electric telegraph. They employed five different needles moved by five different wires, and those needles all indicated different things, and so they were able to speak at a distance. This was employed upon the Great Western Railway, and this was the commencement of that long series of electric telegraphs which now send their metallic threads all over England and over all the civilized nations of the world. Of course, it is necessary that these wires should not touch one another, and that they should be separated from other conductors of electricity, and, therefore, they are insulated, as it is called; they are covered with thread or with something else which keeps them from other bodies. Gauss and Weber hung their wires up in the air. Cooke and Wheatstone first of all employed insulated wires, and carried them underground, but you know now very well that along our lines of railway we see the electric telegraph wires hanging in their various curves as we go along, and we cannot see, but we may imagine, if we please, the messages that are passing along those lines.

But this was only the commencement—the very infancy of telegraphy. It has since had an immense amount of attention paid to it, and an immense amount of success has attended it. Mr. Steinheil, in 1838, stretched wires in the air by insulated supports, just as we see them now arranged on poles. I do not know whether he employed the porcelain which is employed now, but there are various ways in which the wires may be suspended on the poles, so as to keep them from the damp earth. But Steinheil made another important discovery, that is to say, that it was not necessary to have two wires. It is necessary merely that you should have one wire—one wire going from your battery to your instrument, right along where you want to send the message. All that you have to do is to bring your battery in connection with the earth, and your instrument at the other end of the wire, in connection with the earth there also. Large plates are sent down into the ground to some place which is permanently damp, so that the plate may continue in connection with the earth.

Perhaps it may be difficult to explain how the earth acts; but we know that the result is a very satisfactory one. We actually get less resistance than if we employed return wires.

I must say a word about this resistance. You recollect I have spoken of different substances having very different powers of stopping the galvanic current, or, in other words, of conducting the current, and I have said that silver is that which conducts it most readily. Platinum conducts it by no means so well. Now, if we take wires of the same size throughout we find that the amount

of resistance offered by a yard would be just twice the amount of two yards. The thickness of the wire is a still more important element in it. If we have one wire twice as thick as the other, it will offer only one quarter of the resistance. The resistance is inversely as the square of the diameter of the wire. I think I may illustrate this to you in this way. I have taken here a piece of platinum wire, which is thicker in the middle than at the two sides, and upon passing the galvanic stream through it, I have little doubt that we shall be able to show you so much resistance that it becomes quite hot at the sides. [The experiment was performed.] We will increase the power. Now the middle is fairly red hot, but it is at something like a white heat at each end. So that you see that although there is not any great difference in the diameter of those two wires, the thicker one conducts very much better than the side wires, because this heating of the wire is due to the resistance offered to the galvanic stream which is passing though it. One way of explaining the action of the earth—I do not know whether it is a correct one, though—is that, although it is a very bad conductor compared with the metallic wire, it is immensely thick—of illimitable breadth, and by reason of its breadth it is unable to offer any resistance at all. However, whatever be the true explanation of this fact, we now know that it is only necessary to put a battery at one end of a wire, and an instrument at the other end, each in connection with the earth, and we get all the effect we want. And thus we may have a thousand or ten thousand messages running through the wires in different quarters, but still they are all in connection with this one great tank—the great fountain of power which is in the earth itself.

Now I should like to bring before you some of these instruments that are employed. First of all there are some which act by means of the needle which shakes in various ways. One of the simplest is this little instrument. All that is necessary to employ for this is a little chromic acid cell. This box contains the battery and the wire for communication. Here are the letters A, B, C, D, E, F, G, H, and so on, all the alphabet ranged round this dial, and numbers also, and all that I have to do when the current is on is to pass this needle round to the letter that I want to indicate, and then we shall find a corresponding movement on the little dial at the other end. You know generally upon the lines of electric telegraph they call attention by ringing the bell, so I suppose that is the proper thing for me to do in the first instance. What I have to do is to pass the handle out there, and then the bell rings, I do not know whether you can see what I am doing: I have spelt out the name of Faraday, but I am not experienced in this kind of work. The other experiments will be made by those who have had practical experience in working telegraph instruments. We will endeavour to show the same on a larger scale. We will employ one of these A, B, C instruments, and upon the large disc in front of you, you will be able to see what is spelt. You see that in that case the communication is made by wires passing all round the room. You see the festoons of wire hanging from the gallery, Mr. Hibbert is turning the machine, and he can point to any letter he likes—he seems to be taking my hint and spelling Faraday. There are a great many other ways in which messages may be sent besides that. We have upon the table some other instruments in which you can see by the shaking of needles that certain things are indicated. By Morse's arrangement, patented in 1837, by means of a succession of dots and dashes, you are able to make whatever letters you please, and we have here an instrument which works in that way. Then there is Bain's instrument, dating from 1846, which writes upon slips of paper by means of an acid solution of ferrocyanide of potassium, and forms a blue compound of iron. There is a clockwork arrangement by which the paper is passed on. You now see the blue marks upon the paper. I dare say that, after the lecture, you may like to look at that more closely, and Mr. Hibbert will have pleasure in giving you some slips of paper from that instrument. Perhaps one of you would like to write a message to be sent. If none of you will do so, I will write one.

The lecturer then wrote a message and handed it to one of the operators. The message was recorded by dots and dashes on an instrument at another part of the circuit, and read by the second operator as follows:—"Dr. Gladstone wishes you all a happy new year." The following message was then sent in the opposite direction:—"Dr. Gladstone hopes you are all pleased with his lectures."

I perfectly accept the last sentiment, though it was not one which I asked them to send on.

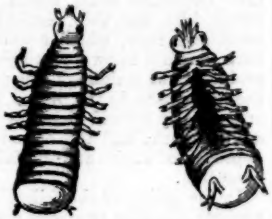
There are various other instruments used in telegraphing. One is in the middle there, and has a single needle. You may see how this needle instrument works—how the needle swings sometimes to one side and sometimes to the other, and sometimes several times to one side, and at other times several times to the other, so as to form a conventional alphabet of letters. This Morse's machine gives a certain clicking sound, and it was found that this sound was all that was necessary to read the message by. The receivers found that they could read by their ears what was being sent, and this fact has been employed very much in America, and it is also being employed in England, by means of what is called the Sounder. We have one of these Sounders here. I may mention that I am indebted to Mr. Johnston, of the General Post Office, and Sir Charles Wheatstone, Mr. Zimmerman, and many others, for the instruments which have been brought before you. You shall now see the Sounder in operation. [The following sentence from the printed notes of this lecture was transmitted from one instrument, and read, by means of the sound, by the operator at the second instrument:—"Besides the use of the voltaic battery for the arts of peace, it has been employed in war."]

I am sure you will accord your thanks to those gentlemen who have been giving us these illustrations.

But I must say a little more about telegraphy. It is perfectly easy, of course, to put up poles, and to suspend wires on the poles, and to communicate in that way. But suppose we want to communicate across rivers, or arms of the sea, or oceans, it is quite another matter. What we have to do then is take our wire and twist round it something which keeps away the water altogether, because water has the power of carrying away the force. Several plans have been

adopted for this purpose, but the one which has generally been employed is this: First of all we take the copper wire. In this specimen there are five strands of wire—five copper wires twisted together. This is better than having one wire, for though one thick wire would conduct better than any one of these fine wires, yet still, to avoid accidents and imperfections in the wire it is better to have several.

Then you take gutta-percha, and work it up into this kind of material. It is gutta-percha cloth, and this is twisted round the wires, and thus you produce a wire with its first coating of gutta-percha. Then by putting more gutta-percha round it you get it into this thicker form, and afterwards thicker still. [Illustrating by specimens.] Thus we have the strands of our electric cable, and we can put this, of course, across a river or across the sea, and the gutta-percha will preserve the wire from the action of the water, or insulate it, as we term it. The first attempt that was made to send a telegraph across an arm of the sea was the laying of the cable from Dover to Calais, in 1850. There were four conducting wires, and they were covered with gutta-percha. The cable spoke when



it was first laid, but failed after one or two days' work. The next year, however, it was laid successfully. It weighs seven tons per mile. You can easily imagine that it would not be very easy to lay a wire weighing seven tons per mile across the Atlantic. But in the great ocean there is this advantage, that the water, at any considerable depth, is very still. In 1853 a cable was laid between Dover and Ostend, and in 1858, a cable weighing only one ton per mile was laid between England and America, but this also ceased to speak almost at once. In 1865 the telegraph was laid to India, across the Persian Gulf, and it was not until the 27th of July, 1866, that there was a successful and permanent junction made between the two hemispheres of the world by means of the electric current. A battery of no very great power is required to work it. It has twelve cells of Daniell. In some of those cables which are about 2,000 miles long, by means of a Thomson's galvanometer, they are able to make communications with a very small power indeed. With two or three cells of Daniell they are able to communicate right across to America. I have here on the table a case containing specimens of the Brazilian cable. These give you the three different parts of the telegraph. This is the shore end, and it is cut across so that you may see that in the middle is the copper wire which transmits the electricity, and then there is indiarubber round it, and then various iron wires, so as to keep it in good order. Then there is more indiarubber, and after that these iron rods wound outside, so as to keep it from any mischief. This shore end has to be rolled among the jagged rocks which are on the sea shore, and exposed to the billows. But when you get fairly into the deep ocean, everything goes on perfectly, and as far as we know, there are no storms of any kind whatsoever, and then we may employ a light cable such as is shown here.

I said just now there were no storms down at the bottom of the sea, but there may be dangers besides those mechanical ones. It has been found in the Irish Sea that the cable has been attacked by some little marine creature, and through the kindness of Mr. Preece I am able to show you this creature. I have got two of them in my pocket—very precious specimens indeed—and in order that you may see them I will throw them on the screen. It was found that the gutta-percha of the cable was bored into by some small animal, and of course you know what the effect would be. It would at once make a communication between the water and the inside of the cable, and then the power would turn away into the water, and we should never get a message at the other end.

A representation of one of the animals was projected upon the screen.

This is a small creature of about a quarter of an inch in length, but we have magnified it with considerable power. This is the creature which eats into the cable. You see, it is made up in various segments. I do not know what the name of the animal is, but there he is before us.* Just imagine the terrible results which may be caused by this creature. One breakfast which he may take may cost more than the breakfast of any luxurious Roman epicure in ancient times, because he may destroy a whole cable, and it may take a year to repair the damage which he may do in a minute.

I think you will agree with me that no more wonderful discovery has ever been made in our own days, than this electric telegraph. I am not sure that any more wonderful invention has ever been made. It is marvellous that we are able to communicate with friends, and to send messages of affection or business across the Atlantic to our American cousins, or to India, or wherever we like, and get instantaneous replies. Think, too, of the great extension of this application of science. Think only of what takes place in the City of London, in the Central Telegraph Office, opposite the Post Office in St. Martin's-le-Grand. There stands a building which is devoted to the electric telegraph. I have taken some statistics from the *Illustrated London News*, and from these it would appear that there are in the building 500 or 600 various instruments such as we have here, and

* I have since learnt that it is a crustacean, known by the name of *Limnoria Terebrans*,

some other kinds besides, and there are about 25,000 voltaic cells. Here are some of the Post Office batteries which have been kindly brought here on purpose for our lecture. They are batteries constructed on a modification of Daniell's principle. There is a Leclanché also belonging to the Post Office. That is, I believe, actually employed for the ordinary purposes of transmitting messages, but here are some employed for more special purposes. This Leclanché battery is working this little instrument at the present time. The Leclanché batteries, as I have explained to you in speaking of them before, last a very long time without being attended to at all, so that they are extremely convenient. There are more than 500 male clerks and 740 female clerks employed at the office in St. Martin's-le-Grand, and the total number of messages sent is about 30,000 a day. As to the speed with which they may be sent, that depends upon other circumstances than merely electricity—upon the power of sending and upon the power of reading off. Sir Charles Wheatstone told me that through his automatic instrument he could send 180 words per minute. That, of course, is very rapid signalling.

(To be Continued.)

ON TELEGRAPH CONSTRUCTION.

By JOHN GAVEY, Assoc. Soc. T. E.

(Continued from page 160.)

3.—*Materials used in Construction, their properties and their selection.*

THE third branch of our subject brings us to the consideration of the materials used for Telegraph Construction; and as a knowledge of their properties, and of the points to be specially observed in their selection and application to various purposes is necessary to the Telegraph Engineer, we propose dealing somewhat fully with the more important items.

TIMBER.

Wood-producing plants are divided by naturalists into two great classes: Endogenous and Exogenous; the former growing by additions of woody matter from the interior, the latter from the exterior. An example of endogenous plants is seen in the common bamboo, and also in grasses; whilst most European trees, such as the oak, elm, pine, &c., are specimens of the exogenous class. The latter is wholly used for telegraphic purposes in this country; and this being one of the most important of the materials required in Telegraph Construction, it may be well to examine briefly its formation.

The bases of ordinary wood are substances termed cellulose and lignin, which have an almost identical chemical composition of 18C. 30H. 15O.; and the physical formation of a tree is comprised principally of cellular tissue, woody fibre, and vascular tissue. Cellular tissue appears to consist of little colourless bladders or vesicles, of various figures, adhering together in masses and filled with liquids. Woody fibre is by some considered as an elongated form of the cellular tissue, encrusted and hardened with various substances, which give the distinguishing characteristics to different classes of timber. Vascular tissue consists of small membranous spiral tubes or vessels, which aerate, and possibly transmit some of the fluids in the plant.

If a transverse section of a piece of timber of the exogenous class, say pine, be examined, it will be found, beginning at the centre, to consist of,—1st, a small portion of central pith. 2ndly, the woody portion divided into the heart wood, the hardest portion of the timber; and the sap wood. 3rdly, the bark, which later is divided into the true bark, and the epidermis; and lastly, the medullary rays, which are thin vertical plates connecting the bark and the pith, and radiating from the centre to the circumference.

If a young shoot just rising from a seed be considered, it will be found to consist primarily of the pith enclosed in a sheath called the medullary sheath, which separates it from the bark. At this early stage, the pith, which consists wholly of cellular tissue, appears to serve as a vehicle for the ascending sap, which, rising from the roots to the leaves, there comes in contact with the atmospheric air, where it combines with the elements necessary to the formation of the tree. Woody or ligneous fibre and vascular tissue, extend vertically downwards, and at the same time cellular tissue is formed horizontally. The ligneous fibres are attached to each other as it were in bundles by their respective coats, whilst the cellular tissue is forced into the thin vertical plates termed the medullary rays, which connect the pith and the bark, and are known to carpenters as the "silver grain." The residue of the sap descends through the inner bark to the roots; thus a layer of wood is gradually formed between the medullary sheath and the bark, and this action continues until the approach of winter and the fall of the leaf stops the operation.

In the spring of the following year the sap again ascends, the like processes are repeated; a second layer of wood is deposited, and so on. As each season advances towards winter the deposit takes place more and more slowly, so that well defined rings may be observed distinguishing each year's growth; the number of rings generally indicating the age of the tree in years, and the thickness of each ring, the speed or quickness of its growth. After a few years the pith dries up, and apparently serves no further purpose in the economy of the tree; and the ligneous fibres deposited nearest the centre become darkened in colour, hardened, more dense, and apparently impervious to the sap, which latter circulates upwards through the layers of woody matter last deposited; hence the distinction between the heart wood and the sap wood. This action continues year by year, the tree increasing by regular deposits of sap wood, which subsequently becomes hardened into heart wood, until maturity is reached, a period which varies with the class of the tree, and with the circumstances under which it is grown. The period of full growth, when a tree is best fitted for employment in mechanical structures is roughly indicated by the following table—

Oak - - - - -	80 to 180 years.
Ash, beech, and elm	60 to 90 ,,
Larch, spruce, and Scotch pine- - -	40 to 100 ,,

After reaching full maturity the tree begins to deteriorate, until, with the lapse of a given length of time, dependent on various circumstances, decay sets in, and the whole is again gradually resolved into its elements. With standing trees this decay

generally commences at the centre and extends thence to the circumference; so that once maturity is reached, a positive evil exisits in allowing timber to remain uncut, if intended for use in the arts. When timber has been cut and is employed in building or construction, it is exposed to different influences, and decay then assumes a different phase.

Decay or rot is known under two forms, viz.:—wet and dry rot—to both of these the presence of atmospheric air and moisture is necessary. The former appears to arise primarily from a fermentation set up by the albuminous portions of the wood, which becoming decomposed, re-act on the ligneous fibres, which in their turn are attacked; and the action appears to result in, or to be followed by, a rapid formation of the lower forms of vegetable and animal life, which draw their sustenance from, and aid in the speedy destruction of the wood. Further, when timber is exposed alternately to much moisture, then dryness, a mechanical action of disintegration, caused by the successive absorption and evaporation of moisture, appears to be called into play, and to aid in the rapid deterioration of the fibre.

Dry rot is a peculiar smouldering action whereby the whole of the tenacity of the ligneous fibres of the wood is destroyed, and the substance is reduced to powder. It is accompanied, or caused by a growth of fungus, termed Merulius Lachrymans,—even the best heart timber is occasionally rapidly destroyed, in a very few years, by this powerful agent; and this is one of the greatest enemies to the durability of wooden ships that exists.

It will be readily seen from the above considerations that, inasmuch as the sap in timber contains in itself the most ready elements of decay, it is advisable in permanent structures to employ such wood as is most free from sap, or to take special steps to eliminate this dangerous inmate. Hence, in the higher class of construction works, the wood containing the largest quantity of sap, is entirely cut away, and only the heart wood is employed; an additional reason for this precaution being that the latter is denser, tougher, and stronger than the former. It will further be obvious that, whether this course be followed or not, it will be necessary to get rid of as much of the sap which the timber holds as is possible; and for this purpose the following precautions are generally taken:—

First, the timber is felled in the winter, when the circulation of the sap is entirely stopped; secondly, in some cases, a ring is cut around the bottom of the tree through the bark and sapwood a year previous to its being felled. This cuts off the supply of sap from the ground, and that which remains in the sapwood from the previous year's growth, becoming assimilated, a large portion of that which would otherwise remain in the timber is withdrawn; and lastly, special processes are adopted either to dry up, to expel, or to neutralize the fermentative portions of the sap; and these will now be briefly described. They may conveniently be considered under two heads—

1st, *Internal Applications.*

2ndly, *External Applications.*

Internal processes are numerous, and may be classed under the following heads—

A. *Seasoning by dry air.*

B. *Neutralizing the sap* by immersion of the timber in various liquids, either with or without extra pressure.

C. *Incorporating preservative* compounds during the growth of the tree.

A. *Seasoning by dry air.* This, which is perhaps the oldest and most simple method of preparing timber for use, merely consists of stacking it in such a manner as to allow a thoroughly free circulation of the air over the whole surface, without exposing it to the direct heat of the sun or to rain. The effect is, that the more volatile portions of the sap evaporate, and the solid portions left behind do not decay so rapidly as those would that are dissipated. All timber should be well seasoned before being applied to any useful purpose, but it should be done carefully for, if exposed to the sun to hasten the process, it is apt to split and crack in all directions. A period of two years is the average duration of the seasoning operations, but even then the timber is not thoroughly dry. In fact, wood being a highly hygrometrical substance, it is impossible to dry it thoroughly in the open air. If it is desired to hasten the operation of seasoning, artificial heat is resorted to, the timber being stacked in a closed shed, and a heated current of air passed over it.

Timber invariably shrinks in drying, and this shrinkage takes place at right angles to the medullary rays; for these being rigid and, to a considerable extent, incompressible, prevent the timber from diminishing its section uniformly throughout. Hence arises the splitting and cracking which is evidenced when timber is dried.

Large timber, such as foreign pine, is frequently roughly squared by having the outer sapwood cut away. This allows the heart wood to dry more readily, and prevents the timber from splitting so much as it otherwise might.

B. *Neutralizing or washing out the sap*, by immersion in fresh or salt water, has also been applied to timber for many years. The effect is undoubtedly to dissolve, and gradually withdraw the fermentable portions of the sap from the timber, so that when the latter is used it is not liable to such rapid decay. Whilst the timber is wholly immersed, all injurious action from the sap is entirely stopped, as the quantity of water, and the almost entire absence of air are unfavourable to fermentation. The removal of the sap is hastened if running water be used; if this process of seasoning is, however, carried too far, it appears to injure the texture of the wood, diminishing its strength considerably.

Immersion under pressure in special acids and salts has of late years been very widely introduced, with varying success, according to the materials used – amongst the most successful of these may be mentioned the following — *Burnetizing*, in which chloride of zinc is the preservative agent; *Kyanizing*, where chloride of mercury is used; *Copperizing*, the agent being sulphate of copper; and *Creosoting*, the most successful of all, in which creosote is forced into the pole.

In these processes, the timber must always be thoroughly dry when it undergoes the operation. This generally takes place in strong cylindrical tanks which are fitted with hemispherical ends removable at will. To save labour, they are usually provided with a line of rails on the lower side, which communicates with tramways running throughout the creosoting yard. The poles being stacked on light trucks or trollies, are thrust into the tanks, the

ends of which being then closed, the interior is exhausted by powerful air pumps, driven by steam. The object of this is to withdraw any moisture that may remain in the wood, and also to create vacuums in the pores which may be filled by the liquid; the liquid is then allowed to flow into the tank, and is exposed to pressure varying according to circumstances. The contents of the tanks, and the quantity of the timber in them being known, the exact quantity of the salt or oil injected into the wood per cubic foot can easily be calculated. The action which takes place, and which so much retards the decay in these instances, is chemical, and it is somewhat obscure. The salts evidently combine with those elements which tend most readily to ferment, and by precipitating them, and forming new and insoluble compounds, check this tendency and lengthens the life of the timber accordingly. Creosote, in addition to the antiseptic qualities of the other salts, fills the pores of the wood with a waterproof composition, which, repelling moisture, is doubtless the cause of the immense advantage which that substance presents over all others in arresting decay.

If a transverse section of a pole treated in the above manner be examined, it will be found that the sapwood alone is permeated with the salt, the heart wood remaining untouched. Inasmuch, however, as the elements of decay are far more fully developed in the sappy portion of the timber than in the heart wood, and the latter is rarely attacked (except in a growing tree) until the former is rotten; therefore, by acting upon the sap wood so as to delay its destruction, we lengthen the life of our timber accordingly. Another method of preserving wood, termed Boucherising, which consists of injecting green timber with sulphate of copper, may be said to combine both the mechanical and the chemical forces previously referred to. Newly-cut timber, before its bark is removed, is exposed at the butt end to a slight pressure of a liquid column of sulphate of copper. The pressure forces the liquid through the longitudinal pores of the timber, till it drops out at the other extremity, both driving the sap before it, and forming the chemical combinations which effect the preservation of the wood. Poles should be exposed to the operation without the slightest delay after they are felled, or the process will probably fail, as the resinous substances rapidly harden and prevent the movement of the liquid salt through the pores. The plant needed is inconsiderable, and it can be set up in any locality, the only requirement being a clear space of open ground. This gives the system an advantage over others, like creosoting, which, intrinsically better, demand expensive and powerful machinery, and are therefore in many cases inapplicable. The arrangements in a boucherising yard may thus be described. An open tank of any convenient capacity is erected on poles at a height varying from 30 to 50 feet from the ground. From this tank descend two leaden pipes about 1½ inches in diameter, one of which is connected with a force pump designed to fill the tank with liquid; the other serving to convey the liquid to the poles. The latter are laid side by side on racks placed horizontally, and they are arranged at right angles to a passage running the whole length of the yard. Down this passage is carried the leaden pipe from the tank, and at regular intervals of 18 inches along this pipe small branch pipes with stop cocks are fitted. As each pole is felled and hauled into the boucherising space, a section is cut off the butt end to expose a fresh uncoagulated surface of wood. Near the circumference of this newly cut surface a strip of india rubber is nailed, then a flat board somewhat larger than the base of the pole is screwed tightly against it by means of iron dogs. A hole in the centre of the board admits of the insertion of a hollow boxwood plug, which is connected with one of the small branch pipes, previously alluded to, by means of a short length of flexible indiarubber tubing. The tap being turned, the liquid solution is driven into the pole, with a pressure dependent on the height of the tank above the racks. After the lapse of a period, varying from two to twenty-four hours, the liquid makes its appearance at the top of the pole, and drops into gutters placed conveniently to catch it. The process is complete when every portion of the top of the pole is found to be saturated with sulphate of copper. This is shown to be the case when a brown stain is left on the timber by the application of a piece of potassium ferro cyanide.

Many preservative processes have been experimented with, but those above described are the most important, and of these creoting and boucherising have perhaps been more widely employed than any others.

As a preservative for timber, creosote has hitherto borne off the palm over all other substances. Its lasting powers appear such, when properly applied, that we have not yet obtained data to show how many years a creosoted telegraph pole will last. The oil derives its antiseptic qualities from the carbolic acid which it contains.

Boucherising has hitherto given such variable and uncertain results, as render its value somewhat doubtful. It certainly increases on an average the life of the timber, to which it is applied, but whether to the full extent that it should is not yet a finally settled question. It appears open to discussion whether those poles, which have been found to fail unexpectedly, had met that careful treatment from the men conducting the operation, which is necessary for the entire success of the process. A little carelessness, in a few cases, or haste to show a large result, may sometimes bring unmerited discredit in a system intrinsically good. It is not, as a rule, successful in sand or chalky soils. Moreover, when in immediate contact with large masses of iron it is said to fail rapidly. Boucherising has been most extensively used on the Continent, and appears to meet with general favour even in localities where timber is cheap and plentiful.

C. *Incorporating preservative compounds* during the growth of a tree.

This system has been experimented on, and the possibility of incorporating certain salts with growing timber, and thereby changing its appearance, and probably its durability, has been successfully demonstrated. It has not, however, been practically applied for telegraph purposes in this country, although it is probable that a wide field for experimental research is open in this direction. The original experiments on this subject were made by Mr. Hyett, and full particulars may be seen in the Philosophical Transactions for 1846.

2. *External applications.*—These consist principally of charring, tarring, painting, and coating

with other preservative compounds. The rationale of their action is the exclusion of air and moisture, whereby the fermentation and disintegration spoken of already would to a great extent be obviated; with good sound well seasoned heart timber this has the desired effect, and witness the doors, window frames in a well appointed house, where the paint is not allowed to deteriorate, the duration is prolonged indefinitely. With telegraph poles, however, one extremity of which is always enclosed in damp soil, it is impossible to exclude moisture wholly; hence decay sets in sooner or later, and the careful maintenance of the protective coating does not insure a really long life to the wood so protected even though this wood be of a good sound quality. With young quickly grown and sappy timber the effect of this surface coating is still of less value, for not only is the wood itself from its sappy moisture more prone to decay, but it splits and cracks in all directions, and admits readily the air and moisture of the atmosphere into its interior.

It will be obvious that no attempts at external protection should be made on firm timber. If it be done, it simply results in enclosing all the elements of decay, and hastening the result which it is desired to avoid. We have had to renew larch poles which had only stood five or six years, through their having been erroneously treated in this manner. If, therefore, green or wet timber has at any time to be employed, it should be allowed to dry thoroughly before any outward application is made.

Where appearance is an object, it is customary to paint poles from the top to a point about three feet from the ground line; from this point to a depth of a foot or eighteen inches a mixture of hot gas tar, Stockholm tar, raw oil, and lime, well boiled together, is applied. This is the point at which decay develops itself most rapidly, and the one to which most attention should be given. Where appearance is no object the pole is frequently tarred throughout its length. It is an open question whether with unprepared timber this is of any use, for the upper portion of the pole will generally, without attention, last as long as the wind and water line will with all ordinary care, so that the application of tar or paint to the former appears superfluous; square timber which is free from sap wood should always be painted or otherwise protected from the weather.

It is well to char or roast over a bright fire the bottoms of all poles that are planted in their natural state (after seasoning) up to about one foot above the ground line. The pole should not be burnt, but the surface alone should be slightly charred.

The wonderful preservative effect of creosote suggests the advantage that would doubtless follow from its local outward application, when the more complete process is rendered impossible by local circumstances. Acting on this some five years ago a quantity of quickly grown open grained larch was treated as follows—

Some long ship's bilge tanks were obtained, filled with creosote, and a fire being lighted under them, the butt ends of the poles were immersed.

These were exposed to the action of the creosote for a period of eight hours, a man being kept washing over with the hot oil those portions not fully immersed. In this manner, about eight feet of the lower extremities of the poles were treated and the result appears to promise fairly, for after four years' exposure there are no signs of decay; although, from the appearance of the timber originally, there is every reason to believe that during that period the sap wood would have shewn evident signs of deterioration, had only the ordinary precautions been taken. The timber used for telegraph poles in England consists principally of the following varieties:—

1. The wild or Scotch pine (*Pinus Sylvestris*), commonly known in this country as Scotch fir. It is native to the Highlands of Scotland, but is grown in England and Wales as well; and is abundant in many parts of Europe. It forms the red and yellow deal imported from the Baltic, in which localities it reaches much larger dimensions than in Great Britain. When imported at maturity, it generally arrives in this country in rough square logs, the bark and the greater portions of the sap-wood having been hewn away; hence in foreign square timber we obtain the most substantial and durable supports for telegraph wires. It is, however, much more expensive than home-grown timber; and although largely used in the early days of telegraphy, it has been to a very great extent supplanted by the latter, in all but exceptional cases. It may be said to be employed only for terminal poles, and other positions where greater strength and larger dimensions are needed, than obtained with the timber ordinarily in use. One method of applying foreign square timber at a moderate cost may, however, be glanced at as serving for light lines, in localities where the ordinary telegraph pole is unobtainable, except at a heavy freight charge. A log of timber, say 20 feet long and 13 or 14 inches square, is cut to exactly a foot square, two saw cuts are then carried down so as to divide the baulk into three planks, each four inches thick by twelve wide; these are cut transversely eight inches broad at one end and four at the other.

It will be seen that we obtain six poles, 20 feet long 8 inches by 4 at the bottom, and 4 inches by 4 at the top from a single log. These dimensions serve for light lines, and the cost per foot run does not exceed that of the cheaper forms referred to below. This system does not admit of application to long poles, as the requisite strength cannot be obtained but by use of logs of an abnormal size, which could not be readily obtained. It is now generally the practice to use young trees for telegraphic purposes with the sapwood untouched, and large quantities of young Pinus Sylvestris are annually imported for this purpose from Scandinavia. If simply seasoned before use, they would decay very rapidly, but being creosoted, a process which is generally applied to them, they become most valuable and probably exceed in durability the more costly full-grown timber, if the latter be not subjected to a like process.

Home-grown Pinus Sylvestris is likewise largely used in a round state, the bark being simply removed and the knots smoothed down. The timber is cheap, but unless special means are taken to retard decay, it rots very speedily. The supply is, however, plentiful, and it can be obtained of any required dimensions. It is generally subjected to some one of the preservative processes already described, boucherising being, perhaps, that most

generally selected on account of the portability of the plant.

2. Norway or common spruce fir (*Abies Excelsa*) is rarely used. Its principal disadvantage is its rapid decay when standing in the ground. We have had to renew poles of this class in the course of three years after their erection. But for this defect it would be useful on account of the great height and remarkable straightness with which it grows. If creosoted, it would doubtless be valuable, but its price would probably preclude its general use.

3. The common larch (*Larix Europæa*) is the most valuable timber for telegraph purposes, in its native or unprepared state, that can be employed. It is, when properly selected, hard, tough, and durable, and is in all respects an excellent material for general use. Preference should always be given to larch grown on poor, chalky, or rocky, and especially mountainous soils, as in such cases the proportion of sap-wood is much less than when rapidly grown in rich soil. It should be cut at from 30 to 40 years' growth, and care should be taken to ascertain that the trees show no sign of rot at the core when cut down. The poles should be felled in winter, when the sap has retreated from the wood; they should contain the natural butt of the tree, and should be free from dead knots and other imperfections. Poles with a large proportion of sap-wood should never be chosen, unless it is proposed "preparing" them with some preservative compound.

4. Pitch or red Canadian pine (*Pinus Resinosa*) is occasionally used for terminal poles, and in other analogous cases. There is but little experience of its value for telegraph purposes in England, as its price, like that of the best Baltic timber, precludes its wide-spread use.

5. Oak. This is one of the strongest and most durable of all the classes of timber employed in the arts. It is, however, too costly for general use in the form of telegraph poles, so that it is only employed in situations where great strength and lightness are needed. Thus it becomes very useful for standards fixed to permanent buildings and other similar objects, and it is largely used for the cross arms, by which insulators and wires are attached to poles.

The other classes of timber do not enter sufficiently largely into telegraph construction to make it necessary to dwell specially on them here. As a matter of course, in foreign countries, where timber differing widely from that most common in Europe is abundant, whilst the latter is scarce, it frequently becomes necessary to employ many varieties extensively. The experience that may, however, have been gained in such cases is generally confined to those directly interested, and but little is generally known in this country of the various results obtained. One of the most important points for consideration, in all materials used in structures, is their ultimate strength when exposed to stress. The ordinary strains to which they are subject tend to cause rupture, either through tearing them apart by a direct pull, by crushing, by shearing, by transverse strain, or by torsion; and it becomes necessary to ascertain the power of resistance each material opposes to either of the above forms of strain. Timber possesses much greater tensile strength, or power of resisting a direct pull in the direction of its fibres, than it does across them; the former being from 10 to 20 times greater than the latter. The following table, extracted from "Anderson's Strength of Materials," gives the force in lbs. per square inch necessary to cause rupture, both by a tensile strain, and by a crushing force; in the latter case only short pillars are referred to.

(To be continued.)

Notes.

We were indebted in our last number to *The World* for a short article on Railways and Post Office Telegraphs. *The World* is one of the most astonishing successes in the press within living memory. It owes its success not only to the startling novelty with which it deals with social questions of the day, to the fearless daring with which it exposes personal villainy, but to the smart and brilliant writing of its clever staff. It is edited by one of world-wide reputation, and personally well known to many telegraphists—Mr. Edmund Yates; and in its columns are to be seen the fine Roman hand and tuneful Dorian mood of an eminent telegraphist whose name is a household word.

Mr. Burton, Director-General of Telegraphs, conducted some highly interesting telegraphic experiments at the National Government House, Buenos Ayres, recently, in presence of President Avellaneda and a distinguished company. The chief attraction was the sending simultaneously different messages in opposite directions along the same wire. The President warmly expressed to the Director-General the great pleasure the experiments had afforded him.

The *Great Eastern* has left the old moorings in the Medway for Milford Haven, where she is going to be laid up for the present. The Telegraph Construction and Maintenance Company have not renewed the charter they had of her, which has just expired. The *Great Eastern* will always be associated with Atlantic telegraphy, to the success of which this ship mainly contributed. It is to be hoped that her services will soon again be required.

The estimated gross receipts of the Anglo-American Telegraph Company for Saturday, July 24th, at 2s. per word, amounted to £1,400, against an actual average in July, 1874, at 4s. per word, of £1,826.

The *Golos* announces the arrival at St. Petersburg of M. La Cour, assistant-director of the Copenhagen Physical Observatory, in order to submit to the telegraphic conference a new invention in telegraphy. That invention gives the possibility of transmitting despatches between two telegraphic stations through one wire only, and by means of many instruments, so that transmission by one in-

strument cannot impede the action of the other. M. La Cour, whilst engaged some years ago in investigating the passage of electric currents through conducting media, found that electricity is transmitted from place to place by undulations analagous to those of sound. In consequence of this discovery, he hit upon an arrangement of electro-magnets and tuning-forks, by means of which a particular current passing through a tuning-fork pitched to a certain note does not become merged in or confounded with other currents which, after passage through differently-pitched tuning-forks, are simultaneously transmitted along the same wire. This, of course, renders it possible to send many messages at a time through a single wire.

The report of the Globe Telegraph and Trust Company (Limited) for the year ending 18th July, gives the net revenue of the company, after deduction of expenses, as £156,539, which, with the balance brought forward, makes a total of £158,154. From this sum £2,624 has been deducted in respect of the expenses of the formation of the company, and special expenses of the proposed new issue of shares; £158,067 has been distributed in interim dividends, and a final dividend for the year of 3s. per share on the preference shares, and 2s. 6d. per share on the ordinary shares is now recommended, making, with the former distributions, a total dividend for the year of 6 per cent. upon the preference and 5 per cent. upon the ordinary shares, leaving a balance of £9,325 to be carried forward. It is mentioned that since the last report 25,437 shares of the Brazilian Submarine Telegraph Company have been exchanged for the same number of ordinary shares of the Globe Company.

The directors of Hooper's Telegraph Works (Limited) announce by circular that, owing to the absence of new contracts since the 1st January, they have decided not to pay an *ad interim* dividend for the half-year ending 30th June last. They add that negotiations are now going on for several important contracts, and one of considerable magnitude has been provisionally arranged. It is also stated that at the meeting to be held on the 20th inst. power will be sought to sanction an issue of debentures.

The Secretary of the Direct United States Cable Company (Limited) states, in explanation of complaints, "that the laying of the cable has been completed, that messages were transmitted over it at a high rate of speed between New York and London, but that a small part of the cable had been injured, probably by the ice, during the laying of the last portion of the deep sea-cable, and that the contractors were now cutting out and replacing the injured part."

At the half-yearly meeting of the Telegraph Construction and Maintenance Company, held to-day, the Chairman, Sir Daniel Gooch, Bart., M.P., stated that the contract for the cable from New Zealand to Sydney was for 1,380 miles of cable, and that it would keep the works of the Company fully occupied for the rest of the year.

The directors of the Eastern Extension Australasia and China Telegraph Company (Limited) offer for subscription an issue of £320,000 in Six per Cent. Debentures to bearer at par, repayable in 1891. The loan is rendered necessary to enable the company to provide the cable which is to connect Australia with New Zealand.

The Western and Brazilian Telegraph Company (Limited), have received telegraphic communication announcing the completion of the cable to Monte Video:—"Land lines between Brazil and Monte Video cut by revolutionists in Uruguay."

GATHERINGS FROM THE EDITOR'S NOTE BOOK.

OHM said—"The chief merit of mathematical analyses is this—it calls forth, by its never vacillating expressions, a generality of ideas which continually excites to renewed experiments, and thus leads to a more profound knowledge of nature."—"Every theory of a class of natural phenomena founded upon facts which will not admit of analytical investigation in the form of its exposition is imperfect, and no reliance is to be placed on a theory developed in ever so strict a form which is not confirmed to a sufficient extent by observation."

According to Gauss (Scientif. Memoirs, vol ii.) the moment of rotation of a bifilar magnet is proportional to the sine of deviation from the position of rest. The magnitude of the directive force of suspension depends, 1st, on the length of the suspending threads (l); 2nd., on their distance apart (d); 3rd., on the weight of the body (w), and it equals—

$$\frac{d^2w}{l}$$

Gauss' multiplier contained 610 coils of copper wire covered with silk = 6,000 feet. It registered thermo-currents generated by the touch of the finger. It also registered frictional currents. Calladon, and subsequently Faraday, deflected needles by conveying common electricity through a wire chain in the same manner as galvanic currents. Faraday proved the minute quantity of a powerful charge. Gauss obtained the current direct from the rubber of a machine moving with a uniform velocity, and found it *sensibly uniform for all resistances*. He adds, "in our experiment, the quantity of electricity in motion depends merely on the play of the machine, and all electricity passing to the conductor in the form of sparks

must traverse the whole chain, be it long or short, in order to equalise itself with the opposite electricity from the rubber."

Harris showed that the intensity necessary to produce a spark depends solely on the density of the air, and not otherwise on the pressure or temperature. The conducting power of flame, of heated bodies, and a vacuum are due solely to the rarefaction of the air in each case.

When the proof plane is a tangent to a surface it coincides with the element which it touches; it takes in some way its plane relatively as regards electricity, or rather it becomes itself the element upon which the charge is distributed. Thus when we remove this plane we do the same thing as if we cut off from the surface an element of the same area and thickness as itself, and which we can carry to the balance without losing any of the electricity which it possesses. Once separated from the surface, this element has in its different points a density only half of that which it had, since the fluid is distributed so as to cover both surfaces of the plane symmetrically. This, however, only occurs when the plane is removed to a considerable distance from the charged conductor.

Atmospheric electricity presents examples of the commutability of physical forces; when the intensely exalted potential manifested in a flash of lightning meets with a good conductor of sufficient magnitude, that is, a body having sufficient capacity to receive and transmit the force, it is transmitted harmlessly to earth; but when that force is impressed on bad conductors, that is, on bodies *not* sufficiently capable of receiving and transmitting it, as the atmosphere and non-metallic bodies of the earth's surface, a portion of that force is converted into, or is manifested in, the form of light, heat, or dynamical force, and thus the gazing rustic is killed or blinded, the stack is fired, the oak is rent, or the tower is shivered to pieces.—*Brookes.*

EXPERIMENTS UPON THE RAPIDITY OF MAGNETISATION AND DEMAGNETISATION OF IRON AND STEEL.

By M. DEPREZ.

In prosecuting my investigations with electro-magnets and their employment in registering very rapid phenomena, I was led to enquire what was the influence of the nature of the iron in the electro-magnet upon the processes of magnetisation and demagnetisation. With this view, I employed a registering apparatus in which the pieces of iron forming the electro-magnet were movable, all the other parts, such as the coils, armature, pointer, &c., remaining the same. To measure the duration of the processes of magnetisation and demagnetisation, I employed the method described in my first communication upon electric chronographs.

The metallic portion of the electro-magnet, which I inserted successively in the magnetising coils, was formed by two cores of 2 millimetres in diameter and 13 millimetres in length. The coils, through which the current was passed, consisted of 14 metres of wire, one-fifth of a millimetre in diameter. The battery used was one Bunsen cell as modified by M. Dulaurier. The different kinds of iron tried were the ordinary iron of commerce, the specially soft telegraphic iron, malleable cast iron, grey cast iron, and, lastly, cast steel drawn and tempered.

The results obtained were entirely unexpected, for the soft iron, the ordinary iron, the malleable cast iron, and *even the tempered steel* gave, very nearly, the same results for the times of magnetisation and demagnetisation, that is to say, duration of demagnetisation, 0.00025; duration of magnetisation (approximately), 0.00150 of a second.

The grey cast iron gave still better results, for the time occupied by magnetisation was about the one-thousandth part of a second. The last-named metal is, therefore, that which would allow the greatest possible rapidity to be attained in the transmission of signals.

The final result is, that with my present registering apparatus, which will shortly be described, perfectly clear signals can be obtained, succeeding each other at intervals of one-three-hundred-and-fiftieth of a second, no matter what kind of iron is used for the electro-magnets, and at intervals of one-five-hundredth of a second when grey cast iron is employed. It should be carefully observed that I do not here speak of *signals following each other in regular succession* at intervals of a three-hundredth-and-fiftieth or five-hundredth of a second, so as to form an equi-distant series. In the latter case a number of signals much greater than 350 or 500 per second could be transmitted.

I am inclined to believe that the superiority of the cast iron is due to its molecular structure, and not to the amount of carbon contained in it. It is therefore my intention to try the *soft iron cast and not forged*, which will, I believe, give results surpassing in rapidity all that I have hitherto obtained. I propose besides in a short time to treat, in another communication, of the details of my experiments, and of the application of my registering apparatus to electric chronographs specially arranged in connection with artillery.

It should be particularly noted that the times indicated above are exclusive of the time occupied by the pointer in traversing its course. This time has to be added to that occupied by the magnetisation and demagnetisation to arrive at the three-hundred-and-fiftieth or five-hundreth of a second for the *total* duration of a signal comprising the demagnetisation, the time during which the pointer is falling, the magnetisation, and lastly, the return of the pointer to its original position. These numbers have reference besides to the case where only a single battery element is used, the number of signals per second transmitted increases with the intensity of the current.—*Association Scientifique.*

Terrible Death by Lightning. — While Nicholas Woodman, a young farmer, was riding, on Sunday afternoon last, at Haydon Bridge, Northumberland, by the side of a gig, in which were two ladies and a gentleman, a severe thunderstorm came on. Mr. Woodman was slightly in advance of the gig, when he was struck by the lightning and killed upon the spot. The horse on which he was riding was also killed, as well as the horse in the gig. The left side of Mr. Woodman was terribly burned, and his coat, vest, and watch were consumed. The occupants of the gig were not hurt.

To Correspondents.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which "The Telegraphic Journal" is the organ, will always command attention. Anonymous correspondence will be wholly disregarded. Literary communications and books for review should be addressed to the Editor; business communications to the Publishers, 10, Paternoster Row, E.C.